INTERACTION BETWEEN DECAYING SHOCK WAVE AND FREE MOVING PLATES IN ONE DIMENSIONAL CONFIGURATION

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WEN-LUNG CHOW

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The interaction of a shock wave with a free moving plate imbedded in an infinite body of fluid, as considered here as a one-dimensional configuration, presents not only a simple model for shock wave effects on structures, but also a problem of wave transformation. For the general case of a compressible fluid, the interaction mechanism is related by the dynamic behavior of the plate, which introduces a boundary condition for the non-linear wave equation for the fluid; whereas the dynamic behavior of the plate depends in turn upon the solution of the boundary value problem.

Problem of this type has been encounted in the fields of underwater explosions and internal ballistics, and both analytic and graphical solutions have been sought.

In publications dealing with underwater explosions, the physical properties of water permit the use of rather far-reaching simplifications. Furthermore, additional sweeping assumptions are usually introduced in the analytical treatments; for example, the boundary conditions for the fluid are assumed to be satisfied at the original position of the plate at any time. In case of ballistic studies, some graphical procedures have been applied.

In this investigation, an attempt has been made to treat the problem as it applied to the motion of thin sheets in interaction with decaying shock waves in air of amplitude comparable to the absolute pressure. Several analytical treatments were based upon a linearized wave equation with constant coefficient, for which case the exact differential equation of the interaction problem was derived. Methods of solution involved different degrees of simplication, referred to respectively, as the simplified, the linearized and the power series

methods. A discussion of the different approximate solution is given with the help of the phase plane. A graphical treatment (linearized-graphical method), based on the same simplification of the wave equation presents the solution of the exact differential equation, within the limits of the finite-difference-procedure. Compressibility effects are then included in the Method of Characteristics, which together with the simplified relations for weak shocks are used in the complete graphical method.

The experimental part of the investigation was conducted by using the shock-tube facilities of the Department of Aeronautical Engineering, University of Illinois. Generally, a good agreement was observed between theoretical and experimental results.

Ranges of applicability for the different methods are discussed, so that reliable calculations may be carried out for plate displacement, plate velocity and pressures at the plate surface as well as at the remote points, all as functions of time.

The functional relationships, including the variables and parameters, are presented in dimensionless form.

VITA

Wen-Lung Chow was born on March 6, 1924 at Hankow, China. He graduated from National Central University and received his B.S. degree in 1946 in Mechanical Engineering. From 1946 to 1949, he worked as assistant engineer first in the Tientsin Electric Power Company and then in the Hankow Power Company, China. In September of 1949, he entered the graduate college at the University of Illinois, and received his M.S. degree in 1950 in Mechanical Engineering. He was a University Fellow from September, 1951 to August, 1953.

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